REMARKS

Claim 2 has been amended to clarify that the first signal beam comprises data modulated by a SLM. This amendment is supported by the disclosure, for example, in paragraph [0030] of the specification, stating: "Holographic system 200 includes a reflective spatial light modulator (SLM) 235 for providing data for holograms to be recorded in media 208." No new matter has been added.

Claim Objections

Claims 45-48 were objected because of certain informalities. These informalities have been corrected as suggested by the Examiner.

Rejections under 35 USC §102

Claims 2-4, 20, 35-37, 40-42, 58, 65, 74-76 and 78-83 were rejected as being anticipated by Liu (US 2002/0015376). This rejection is respectfully traversed.

Liu specifically deals with bit-wise data, which are *not* page-wise data modulated by an SLM. Paragraph [0189] of Liu which specifically states, "In writing data onto the disk 100, a holographic grating is created at the location of one holographic grating elements 102 to represent *a first of two binary states*." Emphasis added. The phrase "a first of two binary states" means that Liu's recording is a bit-wise recording. On the other hand, the embodiments of the claimed invention are based on multiple-bit recording such as a page-wise recording. Only a multiple-bit recording, *not* a bit-wise recording, requires a spatial light modulator (SLM) to be located in a path of an incident beam to generate a first signal beam comprising data modulated by the SLM. In short, Liu does not disclose "a signal beam comprising data modulated by a spatial light modulator" as recited in claim 2.

Rejections under 35 USC §103

Claims 1, 7-13, 29-31, 33-34, 45-51, 68-73 and 84 were rejected as being obvious over Liu in view of Tao.

Claims 21-22, 59-63 and 71 were rejected as allegedly being unpatentable over Liu (US 2002/0015376) in view of Curtis (US 5,703,705).

Claim 32 rejected as being obvious over Liu in view of Tao, further in view of Curtis.

Claims 5-6, 14-19, 23-28, 38, 43-44, 52-57, 64, 66-67 and 77 were rejected as being obvious over Liu.

These rejections are respectfully traversed.

One thing to note is that Liu is strictly a spatial multiplexing (a non-Bragg based technique) and Liu makes no mention of combining this technique with angle multiplexing. The polytopic (page-wise) multiplexing method of this invention requires the combination of angle multiplexing (a Bragg based technique) and spatial multiplexing. Furthermore, Liu only discloses a bit-wise spatial multiplexing technique. There are enormous system differences and some very significant differences in the holographic principles that the bit-wise and page-wise multiplexing techniques are based on. As such, the Examiner's underlying premise that arrives at the "obviousness" conclusion that it would have been easy for persons of ordinary skill in the art of modifying Liu's invention to arrive at the claimed invention directed to polytopic multiplexing is unfounded.

In making the rejection of claims 1, 7-13, 29-31, 33-34, 39, 45-51, 68-73, 84 the Examiner asserts that "an SLM can easily be incorporated in the system of Liu, without affecting any fundamental principle of its operation." Applicants respectfully submit that this statement is incorrect. Persons skilled in the art of holographic data storage would have recognized there are very significant and obvious differences between the system and methods described by Liu and what is claimed in this application. The differences are outlined below.

While it may appear to the Examiner one could easily incorporate an SLM into Liu's system, it is not so. It is not possible without dramatic system alterations; some major alterations need to occur. In all of the cited methods, the reference beam counter propagates with the object

beam and thereby creates reflection gratings in the media. The reference beam and object beam are both focused to a waist that is coincident. If an SLM is incorporated into the object beam (with the inclusion of an extra set of lenses and a spatial filter, neither of which could be considered an easy incorporation), the object beam waist grows proportionally to the number of pixels in the SLM. For example, a 1000x1000 pixel SLM would have a beam waist that is 1000 times larger than the reference beam (linear) and 1000000 times larger than the reference beam in area. This would therefore require a completely different reference beam to ensure proper overlap inside the media, most likely making the reference beam into a plane wave versus a focusing wave. This alone alters the method of Lui's patent beyond the intent of the patent.

In paragraphs 9 to 12 of Liu, US 2002/0015376, Liu emphasizes the complexity of page based holographic storage systems. Liu states in paragraph 10, "Rather, new, completely unique drives are required (for page based holographic storage systems)." Liu discusses in paragraph 10 and 11 that the page based system is *fundamentally incompatible with current CD (bit-based)* technologies. In paragraph 13, Liu proposes the "present method" as a means to backward compatibility with CD technology while utilizing the strengths of holographic recording with the statement, "In these embodiments, the structure of the proposed system is similar to the conventional CD-ROM systems, except that the pit-encoded disk medium is replaced by the holographic grating-based disk medium according to the present invention." It is clear from the statements by Liu, that Liu had no intention and no knowledge of how to "easily incorporate an SLM" into Liu's method of holographic recording, and, in fact, was quite clear that the invention was intended to be used in only a bit based mode that has technological similarities to CD technology. If there was an easy way to incorporate an SLM, Liu would not have made the statement in paragraph 10, "Rather, new, completely unique drives are required (for page based holographic storage systems)" to demonstrate the negative drawback of a page based system. Liu had considered a page based system to be much more complex then the system that Liu proposes in the Liu patent. Thus, incorporating an SLM was not only non-obvious to Liu, who was a person of ordinary skill in the art, but Liu actually states the complexity of the page based systems as reasons for developing the "much simpler" new method by Liu.

In paragraph 9, line 16, Liu states "the aforementioned holographic approach (page based holographic storage) requires sophisticated optics and supporting mechanisms. For example, in the case of digital data, a precise one-to-one mapping between elements of the bit array (SLM) on the disk and the elements of the detector array in the optical head is essential. This requires highly accurate optical heads and drive mechanisms". Liu states this as a reason for developing the bit based method in the Liu patent.

Liu's methods are based on confocal-multiplexing or wavelength multiplexing (see paragraph 13). These types of multiplexing are fundamentally different from angle multiplexing which is the basis behind polytopic (page-wise) multiplexing. There is no mention of angle multiplexing throughout the entire patent of Liu. This is not an oversight by Liu, but rather intentional because angle multiplexing requires a very significant change in the system architecture proposed by Liu. For example, it is a physical impossibility to perform confocal-multiplexing on a page based system. Confocal-multiplexing is by definition a single bit recording multiplexing architecture, and wavelength multiplexing is multiplexing method that is used predominantly in reflection geometries. It is clear by the statements by Liu above, that the only intended multiplexing for Liu's systems were confocal or wavelength, and these are consistent with the drawings and claims of the Liu patent. Even if one considers Tao, which is exclusively angle and spatial multiplexing, it would not be obvious to one skilled in the art how to combine these two concepts because they are fundamentally different multiplexing schemes.

The principles of holography of Liu are fundamentally different from a page based system. In a bit based system, over 92% of the total power is diffracted from the grating localized within a Raleigh range (around a micron for an aggressive lens) of the waist (ref. Hesselink, Optics letters, currently in review) and a very small amount of the useful grating exists in the overlapping regions. For page based systems, the grating exists equally throughout the volume and is much more susceptible to cross talk from its neighbors.

In addition, the Examiner states that a reader skilled in the art could combine Tao (Optics letter article) with Liu to achieve the method proposed. This is incorrect based on two reasons:

Based on the arguments above, Liu is fundamentally a bit based system and the patent makes it very clear that their method is distinct from page based systems. Combining the method of Tao with Liu is like combining two very different architectures and there is no obvious way to do this. Therefore, persons of ordinary skill in the art would not have been motivated to combine Liu and Tao, and even if motivated, would not have arrived at the claimed invention. Liu is fundamentally a bit-wise spatial multiplexing technique and would have been totally non-obvious how this might be combined with an angle multiplexing technique. Furthermore, as stated above, angle multiplexing is never mentioned by Liu.

It is important to understand the fundamental principle behind Tao. Tao's method does not alter the address space of the system, it only improves the usage of media and therefore takes better advantage of its dynamic range. In 1992, when this paper was written, high dynamic range materials were not available and researchers were dynamic range limited in how much information they could store. Therefore, when Tao claims that this method increases the storage capacity, Tao was correct for the media systems that were available. However, current media have much higher dynamic range, and systems are typically address space limited. "Address space" is defined as the number of discrete pages that can be multiplexed onto a disk, even if the media was "perfect" (had infinite dynamic range, etc.). Address space is system metric that is independent of media. Tao's method simply takes a stack of angularly multiplexed holograms and smears the stack in space so that there is no media location that has not been used. Tao's method does not increase the address space of a system; it simply gives a method of gaining a slight increase in media usage efficiency and thereby optimizes the usage of media dynamic range.

In making the rejection of Claims 21-22, 59-63, 71 the Examiner cites that Liu discloses that "all the limitations of the above claims except for teaching that the waists of the signal beams may be formed outside the holographic medium."

Applicants respectfully submit that the Examiner seems to fail to recognize the teachings of Figure 7, 8, and subsequent figures of Liu that illustrate that Liu did in fact incorporate the focus being outside of the media, so there is no need to site Curtis for this. The Curtis patent is irrelevant because Curtis is describing a method called shift multiplexing and this type of multiplexing works

on a completely different holographic principle from angle and spatial multiplexing, and this would be obvious to one skilled in the art.

The arguments cited earlier regarding the substantial difference between bit-wise recording and image (page-wise) recording clearly show that persons of ordinary skill in the art would not have found the claimed invention "obvious" from the teachings of the cited references.
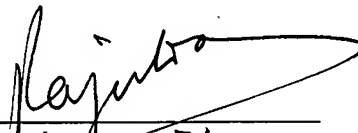
The Examiner has rejected claims 5-6, 14-19, 23-28, 38, 43-44, 52-57, 64, 66-67, and 77 arguing that the limitations of these claims are simply "optimum ranges" and cited *In re Aller*. The Examiner is totally mistaken about the limitations of these claims. These limitations are not "optimum ranges." They are meaningful limitations. Applicants respectfully submit that the Examiner is required to show that these claimed elements and limitations are disclosed *as a whole* in the prior art as is required under the law to establish a *prima facie* of obviousness. As the Examiner has failed to establish that the claimed elements and limitations are disclosed *as a whole* in the prior art, the Examiner has failed to establish a *prima facie* case of obviousness.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue. If it is determined that a telephone conference would expedite the prosecution of this application, the Examiner is invited to telephone the undersigned at the number given below.

In the event the U.S. Patent and Trademark office determines that an extension and/or other relief is required, applicant petitions for any required relief including extensions of time and authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to <u>Deposit Account No. 03-1952</u> referencing docket no. <u>495812005800</u>.

Dated: <u>February 23, 2006</u>   Respectfully submitted,

By _____

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